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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
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PLACER OPERATIONS OF HUMPHREYS GOLD CORPORATION, CLEAR CREEK, COLO.

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BY

E. D. Gardner and Jos. R. Guiteras

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By E. D. Gardner[2] and Jos. R. Guiteras[3]

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6961."

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INTRODUCTION

Humphreys Gold Corporation of Denver, Colo., was conducting a successful placer operation in 1936 on North Clear Creek about 6 miles below Blackhawk in Gilpin County, Colo. About 3,000 cubic yards of gold-bearing gravel are dug daily (September 1936) by two draglines and a power shovel. The gravel is screened in a portable washing plant; the trommel oversize is discarded, and the undersize is pumped to a gold-saving plant. The gold is caught in riffles in sluice boxes. The total cost of mining is about 20 cents per cubic yard.

The mine is in a narrow canyon at an altitude of 7,200 feet. The Blackhawk-Central City branch of the Colorado & Southern RR. runs over the property. Freight platforms for receiving supplies were moved as the workings advanced. The workmen reached the mine on a speeder that ran on the railroad tracks from a point on the automobile highway (U.S. 40) on Clear Creek near the bottom of Floyd Hill, about 5 miles distant. The mine is 36 miles by road and speeder, or 30 miles by rail, from Denver.

ACKNOWLEDGMENTS

Officials and employees of Hymphreys Gold Corporation cooperated in the preparation of this paper by supplying data requested by the authors, and the paper is published with the permission of the company.

HISTORY

Placer mining was begun on upper Clear Creek in 1859. The early miners washed bars and rich surface accumulations mainly by hand methods; some "sniping" has continued until the present. The main channels on both Clear Creek and North Clear Creek have been largely drift-mined. The grade of the stream bed (about 3 percent) did not permit hydraulic mining, and large boulders in the lower reaches of the gold-bearing area discouraged dredging.

Humphreys Gold Corporation began operations in 1932 on Clear Creek about 2-1/2 miles below its junction with North Clear Creek, continued up the main stream to the forks and then up North Clear Creek. At the end of the 1936 season, about 4 miles of the stream beds had been worked. A suction dredge was first used, but after a month's operation it was found to be impractical. The gravel was then excavated for 3 or 4 months in 1933 by a 1-1/4-yard dragline traveling on the land, and was washed on a floating plant. The bouldery ground made digging under water difficult, and considerable gold was lost in the pit. Moreover, much time was lost by rehandling of rocks rejected by a grizzly over the hopper of the washing plant.

Although the methods used during the first two attempts did not prove successful, the work done proved the value of the ground. A screening and scrubbing plant was then built to be used on the bank and a separate concentrating plant was constructed. A trommel with 1-1/4-inch round openings was mounted on the screening plant. The oversize from the trommel was returned to the pit by a stacker, and the undersize was pumped with the wash water by an 8-inch dredge pump through an 8-inch pipe line to the concentrating plant. The pipe line discharged into a wire trommel with 2-mesh openings; the oversize went through riffles and the undersize to two 10-foot-diameter circular jigs, each having a capacity of about 70 tons per hour. The jig tailings went through sluices and the hutch concentrates to a magnetic separator. The magnetic products went to waste and the nonmagnetic material was pumped to a Wilfley table. A streak of concentrate containing the metallic gold went to the amalgamation room, the rest of the concentrates was shipped to a smelter and the tails were run to waste. The capacity of the one table used was insufficient to treat the jig concentrates; to conserve space and to simplify the flow sheet, the magnetic separator and the table were removed. The hutch concentrates were then run through a small sluice to trap coarse gold and were then treated in four 24-inch flotation cells. The flotation concentrate was shipped to the smelter and the tails run to waste.

It was believed that large deposits containing gold-bearing sulphides were present in the bed of Clear Creek as the result of many years of milling gold-lode deposits on the headwaters of the stream, mainly at Central City and Blackhawk. The concentrating machinery was installed to recover the gold-bearing sulphides supposed to be in the gravels. It was found, however, that the sulphides that had been deposited in the gravels had largely been oxidized, leaving fine gold that could be recovered in sluices. The quantity of sulphides recovered did not justify the type of operation, and the use of the concentrating machinery was discontinued. The equipment, however, functioned well; the tailing contained 0.02 to 0.04 ounce gold to the ton.

The present plan of operations (September 1936) was adopted in late 1933. A second 1-1/4-yard dragline was bought in 1933. The two small draglines were replaced by two 2-1/2-yard machines and a power shovel added to the equipment in the autumn of 1934.

Improvements in practice and better digging ground have been responsible for progressively lower operating costs.

The pay gravel will be exhausted at the end of the 1936 season and the equipment will be shipped to Clancy, Mont., about 12 miles south of Helena, for working a deposit of gravel owned by the corporation on Clancy Creek. The draglines, screening plant, and pumping plants will be electrified for the new location.

The yardage handled by the plant from 1934 to 1936 is shown in the following table:

Year	Total yardage	Cubic yards per month	Cubic yards per day
1934 1/	197,249	35,860	1,195
1935 1/	300,880	35,400	1,180
1936 2/	612,144	81,600	2,720
Total	1,110,273		

1/ Mined from main Clear Creek below the forks; operations handicapped by high water.

2/ Mined from North Clear Creek.

GEOLOGY

Clear Creek drains a large area in which many gold mines have been worked. Millions of dollars worth of gold have been extracted from the lode mines above the present placer operations. All of the stream gravel, however, does not contain gold in paying quantities. The operations of the Humphreys Gold Corporation began at the lower end, 1 mile of the stream bed was worked, 1/2 mile was skipped, 1 mile was worked, 3/4 of a mile was skipped, and up to September 1936 3/4 of a mile was worked.

The gold-bearing channel ranges from 75 to 240 feet in width and 5 to 30 feet in depth. The average width that has been worked is 150 feet and the average depth 15 feet. The gold values are spotty. The main channel had been drift-mined over a width of 20 feet for practically the full length of the recent workings. A bedrock flume and a sluice box with block riffles left by the early miners were still in place and exposed in the face of the pit in September 1936. The sluice box was about 4 feet above the flume and a few feet to one side. These evidences of early mining have been followed for about a mile by the present operators. Occasional rich spots are found, which the old-timers missed. The drift miners piled the boulders on the cleared bedrock; occasionally these cause operating difficulties. In places, a second pay streak above bedrock had been drifted.

The gravel is relatively easy digging and easy washing. Numerous boulders over 24 inches in diameter are present, but the ground contains little clay. About half the yardage handled in 1936 was screen oversize (plus 1-1/8 inch). The ground worked in 1935 had less oversize. The gravel contains 5 or 6 pounds of black sand to the cubic yard.

The bedrock, consisting of a decomposed granite and soft schist, has an average slope of 3 percent. Usually, only the top inch or so is skimmed off. Where it contains many crevices and is not too hard, more of it is taken up. An attempt was made to clean crevices in bedrock by hand at a place on the main stream where the bedrock was hard, but the additional amount of gold recovered did not pay the labor cost.

The gold ranges in size from fine to coarse; most of it would be classed as coarse gold. Few nuggets have been found; the largest was worth $17. The gold from the mill tailings in the creek is extremely fine. Some of it is caught on the cloth riffles described later.

In September 1936 the flow of North Clear Creek was about 10 second feet. At times this creek does not supply enough water for washing operations without recirculation; at other times floods fill the pit with mill tailings and debris brought down from above. Clear Creek proper is a much larger stream; control of the main stream below the junction contributed appreciably to the cost of former operations.

SAMPLING

The ground is sampled ahead of mining. At the beginning this was done by digging pits. A steam drill was used in 1934; it was replaced in 1935 by a gasoline self-propelling rig mounted on crawler treads. Six-inch holes are drilled. Holes are generally spaced 30 feet apart in rows across the canyon; the rows are at 1/4-mile intervals. Cost per foot of drilling varied greatly according to the depth of holes and character of the gravel. The costs ranged from $2.25 to $5.00 per foot of hole drilled.

The value of the gravel being mined is estimated by panning and counting the colors of gold in each pan; these estimates are checked from time to time by weighing the gold and computing its value against the volume of the sample. This work is done on day shift by one of the oilers previously trained in the sampling crew. Testing of the ground is conducted as a separate operation.

The amount of gold recovered from individual blocks does not check very closely with the amount indicated by drilling, but the overall recovery checks fairly well. In September 1936 the gravel treated was richer than drill sampling indicated. On North Clear Creek early hand working was extensive and in worked ground comparison of drill sampling with operations shows necessity for close drilling to give a dependable average. On Main Clear Creek below the forks hand workings were not so extensive because of the rapid large stream, and drill results checked more closely with operating results.

In 1935 a comparison was made between the gold recovered and that indicated by drilling for a portion of the gravel mined. Estimates made from the drilling indicated the area contained 214,193 cubic yards averaging 43.88 cents per yard. Actually, 177,651 cubic yards were mined, with a recovered value of 60.95 cents per cubic yard, as calculated from mint returns. The yardage mined was 83 percent of the original estimate, and the recovered value was 139 percent. The estimated total money value for the area mined was $93,997, as compared with an actual recovery of $108,273, or 115 percent of the estimate.

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WATER SUPPLY

Water for washing and screening the gravel is pumped from the creek by a 10-inch centrifugal pump powered by a 115-horse power, 4-cylinder, gasoline engine and mounted on a self-propelled tractor chassis. The pump is operated at 680 to 700 r.p.m. and supplies about 1,500 gallons per minute. The water is delivered to the screening plant through an 8-inch line made of alternate 25-foot lengths of iron pipe and rubber hose. The length of the line varies from 50 to 300 feet (fig. 1). The water is muddy as a result of dumping tailings from concentrating mills into the creek above the placer operations. The pressure at the washing plant is about 60 pounds per square inch.

Additional water is needed for the gold-saving plant. About 800 gallons per minute are pumped to that plant from the pit by a 6-inch self-priming centrifugal pump powered by a 50-horse power gasoline engine. This pump is mounted on wheels. When it is on level ground, it is pulled ahead by a tractor; when it is in a hole, it is picked up and moved by one of the draglines.

GENERAL PLAN OF OPERATIONS

The plant consists of two draglines on the bank ahead of the advancing face, a washing and screening plant between the draglines, a power shovel in the pit, and a gold-saving plant some distance behind on the tailings pile. The washing plant is moved up with each cut across the face; the gold-saving plant periodically. The general plan of working in September 1936 is shown in figure 1. The flow sheet is shown in figure 2.

The creek is diverted into a new channel dug by a dragline along one side of the ground being worked. The pit is drained by a ditch in the bottom of the pit next to the diverted creek. A flood in August 1936 shut down the plant for two days while a new drain to the pit was being cut by a dragline.

Where the channel is less than 180 feet wide, the entire face of the pit is advanced at one time; where the channel is wider, half of the face is advanced at a time. Where the pit is mined in two sections, the first is advanced 150 to 200 feet and then the equipment is moved back and the other section is mined. Usually, one setting of the gold-saving plant and the main pump will serve both sections.

The tailings (oversize) from the screening plant are piled in the middle of the pit when only one cut is taken. The sand tailings from the gold-saving plant are stored on the side next to the railroad track, and the other side is left open for drainage. When two cuts are taken, the oversize is stacked in two rows.

Where the railroad track is on pay gravel, it is shifted. The excavation, when close to the railroad track, is filled flush with the top of the side bank with sand tailings as the face of the pit is advanced, to prevent subsidence of the roadbed.

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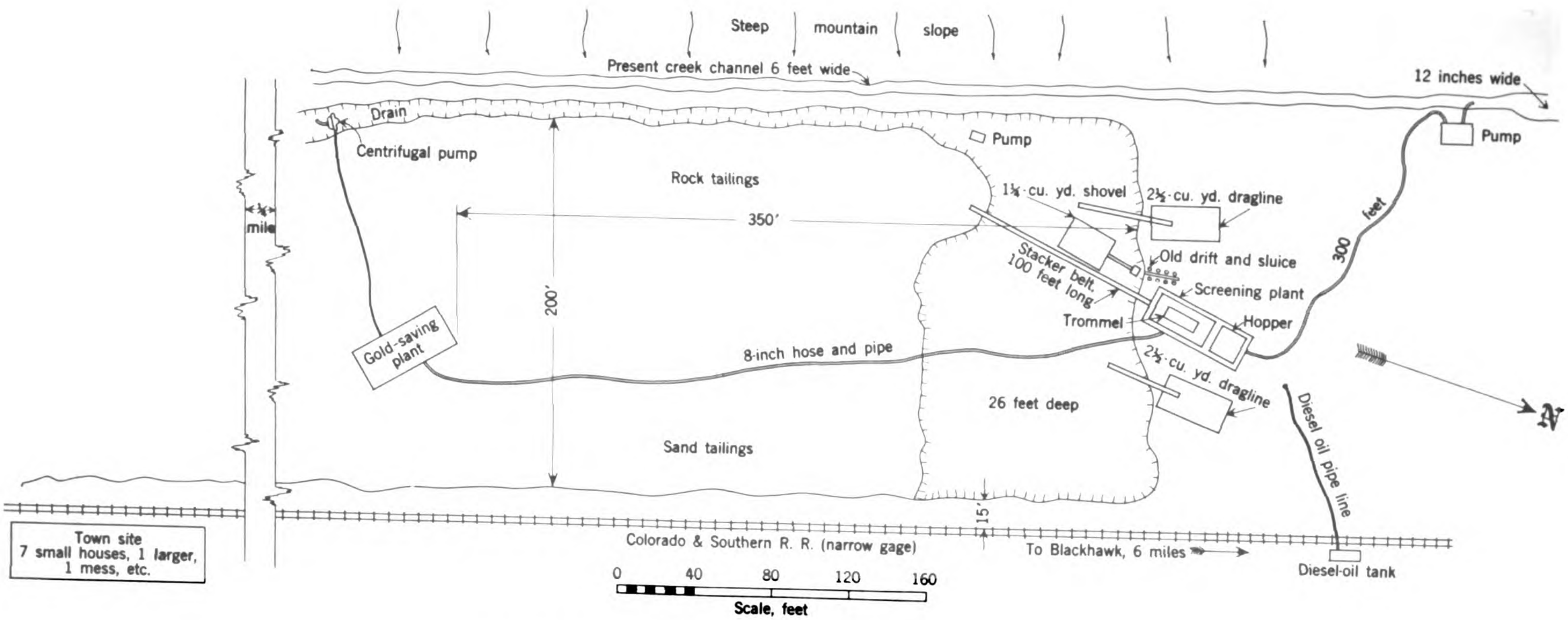

Figure 1.—Plan of Humphreys operations, North Clear Creek, Sept. 19, 1936.

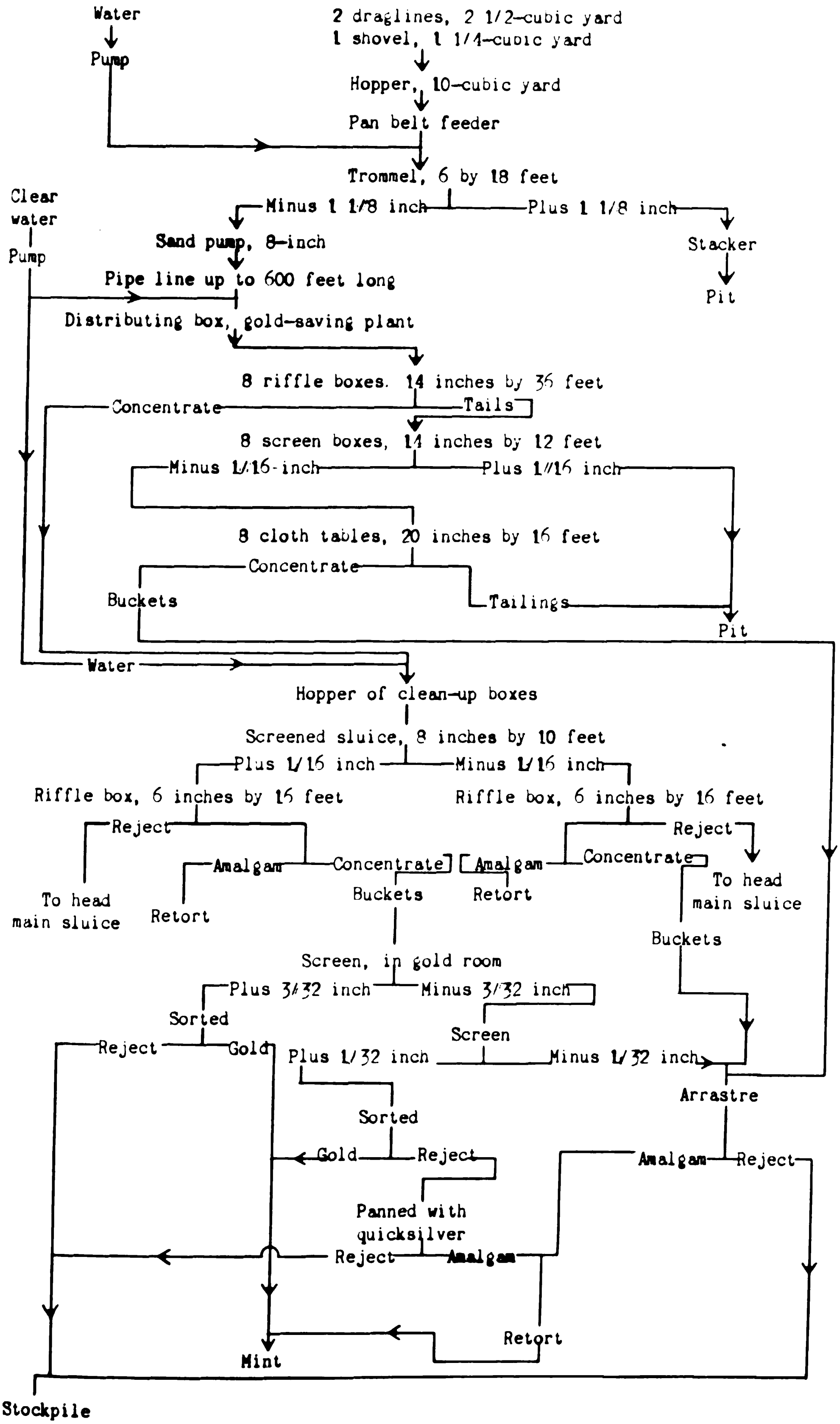

Figure 2.- Flow sheet of operations, Humphreys Gold Corporation.

Overburden is stripped and cast aside by the draglines where it is low in gold content; values and physical or topographical conditions make it advisable.

Dams 5 feet high and the width of the cut are built near the face to keep the water from the sand tailings out of the part of the pit that is being worked. A new dam is built about once a week. A drain is kept open at the end on the creek side to permit the water that seeps down on bedrock to get away.

The screening plant is moved ahead 20 or 25 feet at a time. The average time required for moving up is 40 minutes. The gold-saving plant is moved ahead 200 feet or less at a time; the average time consumed in moving up is 3 hours. Both plants are self-propelled. In September 1936 the traction gears on the screening plant were broken and it was towed forward by one of the draglines.

Mining continues each season until prevented by cold weather. A sustained temperature of 15° F will stop operations. Ice first affects the stacker belt by causing the drive pulley to slip. The pulley is heated by a blow torch, and three barrel stoves are used along the stacker to heat the belt during cold weather in the fall and spring. The plant was shut down from November 1935 to the middle of March 1936, during which time repair and remodeling work was carried on.

Rough sections of the area to be excavated are smoothed over with a caterpillar tractor equipped with a road blade. A pump is mounted on the tractor and is used for emergency pumping. The tractor is also used for preparing a new roadbed for the railroad when it is necessary to move the track. The railroad track has been moved four times. The tractor has been used for moving equipment and doing other odd jobs; it has proved to be a handy tool.

Oil and grease that drop on the ground from the draglines and the screening plant are cleaned off ahead of excavating; otherwise, they would cause some of the gold to float through the sluices.

A gasoline speeder is used on the railroad for transporting men and light supplies from the automobile road to the workings. The speeder and a trailer will carry one shift of workmen. The speeder is also used for transporting men between the camp and their work at the beginning and end of a shift and at meal time.

In good digging ground the draglines, can overload the screening plant. In September 1936 the capacity of the screening plant limited the yardage handled in a day.

EXCAVATION

The gravel is excavated by two full-revolving draglines with 50-foot booms and 2-1/2-cubic yard Esco buckets. The draglines are mounted on crawlers and powered with 150-horse power gasoline engines. They are capable of excavating to a depth of 30 feet. A 1-1/4-yard full-revolving Diesel shovel with a 22-foot boom is used in the pit for cleaning bedrock, moving large boulders, and digging out corners that the draglines cannot reach. The section of the bank directly under the stacker from the screening plant is dug with the shovel and the material is dumped where a dragline can reach it easily. When the shovel is not used in the pit, gold recovery drops off. The shovel is also used for leveling off the piles of coarse tailings, for moving the gold-saving plant, for building dams to keep the water from tailings out of the pit, and for excavating a channel for the creek. The dragline and shovel operators do their own repair work under the direct supervision of the assistant superintendent.

The two draglines can take a cut 150 feet long with a single set-up of the screening plant; with the help of the shovel, a 200-foot cut can be taken. The face of the bank is advanced from 20 to 25 feet for each position of the screening plant.

The excavating equipment can handle 4,500 cubic yards bank measure each day of 20 hours, with no delays in good digging ground. It was averaging about 3,000 cubic yards daily in September 1936 when easy-digging gravel was being handled. The average for 1936, however, as previously shown, was 2,720 cubic yards. In good digging ground each dragline will excavate and dump one bucket per minute. Operations are slowed down by high water and bouldery ground and sometimes are impeded by high concentration of tailings deposited in the creek bottom from the mills upstream.

The draglines and shovel are equipped with caterpillar traction. The treads on the draglines are 15 feet long and 24 inches wide; the gage is 12 feet.

The buckets on the draglines have four teeth, which cost $3.50 and must be replaced every 3 days. Repointing the teeth and tipping them with stellite did not prove profitable; the worn teeth are discarded.

A special lip of 1-inch manganese steel is used on the shovel dipper to permit even digging in cleaning up bedrock. Teeth on the dipper made grooves in the bedrock, causing the loss of some gold. The special lip is used on the dipper for all digging.

The digging cables on the draglines are 1-1/8 inch in diameter, Lang-lay, and 65 feet long. They are run to failure and require about 30 minutes for replacement. They average 150 hours of service. The hoist cables on the draglines are 1 inch in diameter and 130 feet long; they last about 800 hours. The hoist line on the shovel is of 7/8-inch cable.

Timber from the old sluice, including the block riffles and similar trash, is put through the trommel. Any gold remaining in the old riffles probably is loosened by this treatment.

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WASHING AND SCREENING

The washing and screening plant consists essentially of a hopper feeder, trommel, stacker, and sand pump. The entire unit is mounted on a caterpillar-tractor chassis and is propelled by a 150-horse power gasoline engine. The plant has a steel framework and a flat bottom. The sheave for raising and lowering the stacker is in an "A" framework at the top. The plant weighs 125 tons and is full revolving on its crawler base.

The plant runs with little interruption; only a small part of the lost time, other than for moving, can be attributed to it. Before each move the ground that is to be occupied by the plant is smoothed by one of the draglines in order that the plant may be set level.

Hopper

The gravel is dumped by the draglines into a hopper that holds 10 cubic yards. The top of the hopper is 18 feet above the ground. There is no grizzly; boulders too large for the plant to handle are sorted out and pushed aside by the shovel in the pit.

Feeder

The bottom of the hopper is the lower end of a 42-inch by 16-foot pan belt feeder, which discharges the gravel into a chute to the trommel. The speed of the feeder can be varied; usually it is 18 to 20 feet per minute. The rate of feeding the plant is controlled at this point. The trommel discharge on the stacker belt is watched; if it is dirty, the feeder is slowed down. The present slope of the feeder is the maximum slope at which it will work efficiently. It appears to be too steep for wet weather and plans have been made to use a flatter slope after the present season.

Trommel

The trommel is 6 by 18 feet; the screen plates, of which there are five rows, are made of cast manganese steel. The holes in the screens are all 1-1/8 inches in diameter. The screens are cast to give an outward flare to the holes in order to minimize blinding. The trommel slopes 2 inches to the foot; it is driven at 11 r.p.m. by a 50-horsepower gasoline engine. Although boulders up to 40 inches across can be handled by the trommel, an effort is made not to put any through over 24 inches in diameter.

Water is pumped to the plant through the 8-inch line previously described. Two 2-inch pipes with flattened ends serve as nozzles to spray water on the incoming gravel at the head of the trommel. As the gravel moves through the trommel it is further washed by sprays issuing from slots in the bottom of a 5-inch pipe that extends into the trommel near the top.

The oversize from the trommel drops onto the conveyor belt of the stacker; the undersize flows into the suction box of the sand pump.

Stacker

The stacker is 100 feet long, which is long enough for the ground being worked. The discharge end can be raised and lowered. The stacker belt is 5/8 inch thick and 36 inches wide and travels at a speed of 200 feet per minute. It delivers the trommel oversize to a rock pile behind the working pit.

The stacker belt and the trommel feeder are driven together by a 40-horsepower gasoline engine.

Sand Pump and Pipe Line

The undersize from the trommel is pumped by an 8-inch, manganese-steel sand pump through an 8-inch line to the gold-saving plant. The pump is driven by a 150-horsepower gasoline engine. The maximum length of the pipe line is 600 feet. It is made of alternate lengths of iron pipe and rubber hose. The maximum life of the iron sections is 6 months; the hose lasts about 18 months. In a few places two iron sections are joined together. Victualic connections are usually used for this purpose, as they permit some flexibility. Practically no gold collects at these connections but some is held back where standard connections are used. It is recovered when the pipe is disconnected for moving or replacement.

The sand pump breaks up any balls of clay that get through the screen, and thus contributes to the washing of the undersize.

No gold is recovered in the suction box or elsewhere on the washer.

GOLD-WASHING PLANT

The gold-saving plant is mounted on the chassis of a crawler crane and is propelled by a 90-horsepower gasoline engine. The caterpillar treads are 12 feet long, 15 inches wide, and have a 10-foot gage.

The ground is leveled off before the plant is set on a new site. The machine is equipped with hydraulic jacks for leveling it across the line of sluices, should that be found necessary. The base of the plant is built up in order that there may be sufficient elevation for tailings disposal.

Gold-Saving Equipment

The method of saving the gold is patterned after standard gold-dredging practice. The undersize from the screening plant is discharged into a distributing box at the top of the gold-saving plant, from which it flows through pipes to sluice boxes. Clear water from the pit is pumped into the distributing box through a 6-inch pipe. The gold-saving equipment consists principally of eight main sluices set in two banks of four sluices each, one bank on each side of the plant. The sluices are each 14 inches wide and 48 feet long. The first 36 feet contains riffles and the bottom of the last

12 feet is a screen with 1/16 by 1/2-inch holes. The speed of the top of the water through the main sluices is a little less than 10 feet per second. The grade of all of the sluice boxes is 1-1/4 inches to the foot. The undersize from the screens in the main sluices drops to the head of eight 20-inch sluices, four on each side of the plant. They are 16 feet long and lined with corduroy cloth. The cloth plant was put in to recover extremely fine gold that is carried over the riffles in the main sluices; it is thought that this gold comes mainly from mill tailings. The lower ends of the corduroy boxes are suspended from a rope block, which permits easy control of the slope.

The riffles in the main sluices are strips of 3/16-inch iron; they are 1-1/4 inches high and are set 1-3/8 inches apart, with the tops sloping down-current. They are welded to end-pieces in sections 3 feet long. Quicksilver is used in the riffles; 5 pounds of it is sprinkled in the heads of the main sluices daily. The quicksilver loss is 4 to 5 pounds per month. Corduroy cloth is used under the riffles in the lower section of the boxes.

Tailings Disposal

The gold-saving plant is equipped with two dewatering tanks, which are used when there is a shortage of water. A 6-inch sand pump driven by a 40-horsepower gasoline engine discharges the dewatered tailings through a pipe. In September 1936 the dewatering tanks had been removed and the tailings were being discharged through a tail sluice at one end of the plant.

Sampling of Tails

The sluices on one side of the plant discharge into a cross box 14 inches wide and 16 feet long. The bottom of the box is arranged in the same manner as the 8-inch clean-up box described later. A sample is taken every half hour of one shift each week. Plugs are pulled in succession from a series of holes in the side of the box and about a gallon of water and tailings is drawn from each into a bucket. The half-hour series of samples are combined, settled, and reduced in size before being shipped to Denver for determination of the contained gold.

Method of Cleaning Up

The sluice boxes are cleaned up by two men on day shift. The feed is shut off from one sluice at a time at the distributing box and each is cleaned in turn. The first 15 feet of each main sluice is cleaned up twice a week; the rest of the sluice, once a week. The main sluices are cleaned up by taking out one 3-foot section of riffles at a time and shoveling the concentrate into a bucket. No water is used. The bottom section of riffles is left in until the final cleaning is completed, as a precaution against flow of water and gravel down this sluice. The greater part of the gold is obtained from the upper 15 feet of the sluices. Pyrite from mill tailings is caught in the riffles, but it causes no trouble except occasionally when an unusually large amount of tailings comes through the plant. Some iron oxide pebbles, shot, and the usual small hardware also are caught in the riffles.

The concentrate is cleaned in special clean-up boxes. The buckets of concentrate are dumped into a hopper. Water from a pipe connected to the fresh-water supply washes the concentrate into an 8-inch box 10 feet long with a screen with 1/16-inch holes 3/4 inch above the bottom. The screen oversize goes to a 6-inch box 16 feet long with riffles similar to those in the main sluice. The riffle sections are 3 feet long and fit the 6-inch box. The 8-inch box has grooves seven inches apart cut diagonally across the wooden bottom. At the lower end of each groove is a 1-inch round hole bored in the side of the box. Through these holes the screen undersize runs into another 6-inch box. This 6-inch box is made of iron; it is 16 feet long and has the same kind of riffles as the main sluice, except that the 3 sections at the head end have tight-welded bottoms. The concentrate from each section is emptied into buckets for further treatment in the clean-up house. Concentrate from the upper sections of the coarse clean-up box is hand panned, and rejects, together with concentrate from the lower section, are run through the same box several times; the final concentrate is taken to the clean-up house for amalgamation. Between an ounce and ten ounces of gold is recovered each week from the concentrate from the coarse clean-up box.

Each of the lower sluices is cleaned up weekly. The cloths are first rinsed in a tub and then scrubbed with a brush on a drain board. The concentrate is taken to the clean-up house for further treatment.

Method of Treating Amalgam and Sluice Concentrate

The weekly clean-up from the sluices usually consists of three 2-1/2-gallon buckets of fines, 1 bucket of coarse, and 6 buckets of cloth concentrate.

In the clean-up house the coarse concentrate is screened through a 3/32-inch screen and then through a 1/32-inch screen. The oversize from each screen is sorted for gold nuggets. The minus 3/32-inch plus 1/32-inch screen size is then panned with quicksilver. Less than 10 percent of the recovered gold is in the coarse sizes.

The fines are treated in an arrastre consisting of a 48-inch cast-iron bowl in which two iron shoes revolve. The riffle concentrate is ground 2 hours in the arrastre with quicksilver. About one-eighth of a pound of lye is added to each charge. The unscreened concentrate from the cloth is treated in the arrastre separately.

The concentrate from the arrastre is drawn off and panned. The amalgam is squeezed and retorted. The retort holds about 2 quarts of amalgam. The retort is lined with heavy paper and the bottom is chalked before being heated. Heat is supplied by a gasoline burner.

The charge is not melted in the retort, as the mint prefers to receive the sponge. The condenser is a 3/4-inch pipe 30 inches long. It is inside a 2-inch pipe, and is cooled by cold water circulating between the two pipes.

From 3,000 to 12,000 grams of amalgam are retorted weekly. From 5 to 15 percent of the amalgam represents gold recovered from the cloth riffles. The amalgam contains about 60 percent gold. The bullion is 850 to 860 fine in gold and about 140 fine in silver. It contains nearly enough silver to pay the mint charges.

The reject from the clean-up consists mainly of sulphides with some magnetite and garnet. It is saved for possible shipment. Most of the gold in the reject is probably carried in the sulphides. The heavy minerals with the gold cause no undue difficulties in the clean-up.

Recovery

The recovery of gold in the gold-saving plant is determined by sampling the heads and tails and averages about 90 percent. Based on comparative weights of amalgam, 93.2 percent of the recovered gold was obtained from the sluices and 7.3 percent from the corduroy table section. Corduroy was used only during 1936.

CAMP

The camp consists of 7 portable cabins accomodating 4 men each, an office in which the superintendent and assistant superintendent sleep, and a combined cook-house and dining room.

The buildings are of sectional design and are easily knocked down for moving; parts are bolted together. The camp has successively been moved to two new sites.

LIGHTING

Kohler lighting units are placed on the principal pieces of equipment and at the camp, as follows:

Camp - one 1,500-watt unit, fully automatic.

Washing plant - one 1,500-watt unit with seven 60-watt and one 200-watt drop lights. A 200-foot cord runs from this plant to the main pump.

Gold-saving plant - one 800-watt unit.

Draglines and shovel - each has a 1,500-watt unit. Two 200-watt drop lights back of reflectors and three 60-watt drop lights are used on each digging unit for night work.

OPERATION

Two 10-hour shifts are worked. Each crew misses one shift per week. The mine is shut down at 3 o'clock every Saturday afternoon, and is started again Sunday evening. Most of the men go to their homes for the week-end.

The average digging time during each 20-hour day is about 15 hours, or 75 percent.

During 1936 the plant operated 69.1 percent of the total shift hours. The delays, comprising 30.9 percent of the working time, were apportioned approximately as follows:

	Percent
Screening plant:	
Moving	20.8
Engines	8.9
Pumps	4.4
Feeder screen and conveyor	7.5
Lubrication	1.6
Gold-saving plant:	
Moving	5.6
Water and pipe-line system	10.0
Draglines	3.4
Shovel	1.0
Cold weather (April to May)	8.9
Sundry	27.9
Total	100

LABOR

The amount and cost of labor in September 1936 was as follows:

4	dragline runners	$1.00	per hour each
2	shovel runners	1.00	do.
2	washing plant operators	.70	do.
2	washing-plant helpers	.50	do.
2	gold-saving-plant operators	.60	do.
2	gold-saving-plant helpers	.50	do.
2	pumpmen	.60	do.
1	oiler and panner (day only)	.60	do.
1	oiler (day only)	.50	do.
2	clean-up men (day only)	.60	do.
2	gasoline-car operators	.50	do.
1	timekeeper	150.00	per month
1	foreman		
1	assistant superintendent		
1	superintendent		
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Some of the men go to their homes each night but most of them live on the job and go out once a week. Room and board costs $1.35 per day.

In addition to the mining crew, a drilling crew of 8 men and a boss working on 3 shifts per day is employed to sample additional ground ahead.

POWER

The entire plant uses about 600 gallons of gasoline, 50 gallons of Diesel oil, and 13-1/2 gallons of lubricating oil daily. The gasoline is bought in 6,000-gallon tank-car lots and is delivered to the job by the railroad. It is stored near the workings in two 5,500-gallon tanks. The Diesel fuel is bought in drums. A pump driven by a 6-horsepower gasoline engine pumps the gasoline to the head of the pit through a 1-1/2-inch pipe-line. A 150-foot gasoline hose at the end of the pipe is used for fueling the two draglines, the washing plant, and the main pump. In September 1936 the gasoline (without road tax) and Diesel fuel each cost 10-1/2 cents per gallon laid down at the plant.

The engine set-up is as follows:

	Horsepower
Water supply:	
8-inch pump	115
4-inch pump	50
Excavators:	
2 Draglines	150
	150
Shovel	130
Washing and screening plant:	
Tractor	150
Stacker and feeder	40
Trommel	50
Sand pump	150
Gold-saving plant:	
Tractor	90
Sand pump (occasional use only)	40
Gasoline pump	6
Arrastre	1
Total	1,122

In addition, there are five 1,500-watt and one 800-watt lighting plants and a gasoline-powered welding unit on the job.

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COSTS

Costs of Mining

The costs of mining varied with the operating conditions, such as width and character of gravel (costs were higher when only one of the two draglines could be used) and water supply. Direct operating costs ranged from 12 to 20 cents per cubic yard, bank measure, before depreciation and between 15 and 25 cents after depreciation but not including depletion.

Cost of Plant

The cost of the plant was approximately as follows:

Two 2-1/2-yard gasoline draglines.......	$ 40,300
One 1-1/4-yard Diesel shovel............	19,900
4 dragline buckets......................	6,000
Screening and gold-saving plants........	70,000
Water-supply equipment..................	3,500
Clean-up equipment......................	1,000
Other equipment.........................	6,500
Total................................	$147,200